

Assignment 3: Runway Aircraft Performance Calculations

Date Due: February 16, 2026 (midnight)

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Problem 1

A new airline is evaluating two aircraft to operate flights from Phoenix International (PHX) Airport. The following table shows the aircraft proposed by airline executives. Two long-haul, origin-destination pairs the airline would like to fly with the selected aircraft are: a) PHX-LHR and b) PHX-FCO.

Table 1. Aircraft Considered in the Airline Evaluation.

| Aircraft Considered |
|--|
| Below: Boeing 787-9 with Typical Rolls-Royce engines. Aircraft maximum design takeoff weight is 561,500 lb. 290 seats in a two-class layout.  |
| Below: Boeing 787-8 with Typical Rolls-Royce engines. Aircraft maximum design takeoff weight is 502,500 lb. 242 seats in a two-class layout.  |

The design airport temperature used should be the average of the maximum daily temperatures of the hottest month of the year. More detailed information about the airport can be found at the AIRNAV database available on the web at: <http://www.airnav.com/airports/> or visit the airport site.

In your analysis use the latest version of the Boeing documents for airport design.

- a) Find the average stage length to be flown between each one of the critical OD airport pairs. In your analysis use the Great Circle Flight Path mapper link provided in our interesting web sites. Add 6% to the distances calculated to account for real Air Traffic route conditions and to account for possible weather deviations from the optimal Great Circle flight path.
- b) Find the runway length needed for each of the aircraft operating the critical route. Determine if PHX has enough runway length to support these flights with all seats full.
- c) Estimate the average fuel per passenger assuming a full passenger load on both routes. Can the airline achieve good fuel savings using the Boeing 787-9?
- d) Using the Payload-Range diagram of each aircraft, and using the longest flight of the two routes, find the Specific Air Range (SAR) parameter for each aircraft. Comment on the SAR values calculated.
- e) Considering various factors which aircraft is the best for this airline? Explain.

Problem 2

An airline is evaluating the Boeing 737-9 Max aircraft to operate flights Ronald Reagan National Airport (DCA) to San Diego (SAN) and Denver (DEN). The following table shows the aircraft in question.

Table 1. Aircraft Considered in the Airline Evaluation.

| Aircraft Considered |
|--|
| Below: Boeing 737-9 Max with CFM LEAP-1B28 engines. Aircraft maximum design takeoff weight is 194,700 lb. 193 seats in a two-class layout. |
|  A Boeing 737-9 Max aircraft, painted in the Alaska Airlines livery with a blue and white color scheme and the airline's logo on the tail, is shown on a runway. The aircraft is positioned horizontally across the frame, facing towards the right. The background shows a concrete wall and some airport infrastructure. |

The design airport temperature used should be the average of the maximum daily temperatures of the hottest month of the year. More detailed information about the airport can be found at the AIRNAV database available on the web at: <http://www.airnav.com/airports/> or visit the airport site.

In your analysis use the latest version of the Boeing documents for airport design.

- a) Find if the flight to San Diego is possible from DCA with a full load of passengers considering the airport elevation and runway length constraints today. State any limits found in your analysis.
- b) Find if the flight from Denver to DCA with a full load of passengers is possible considering the airport elevation and runway length constraints at Denver. State any limits found in your analysis.

- c) Considering the analysis above, explain the effect of airport elevation on runway length.
- d) What is the maximum thrust rating for the CFM LEAP-1B28 engine at sea level and static conditions?

Problem 3

Use the Small Aircraft Runway Length Analysis Tool (SARLAT 2) to **evaluate the existing runway** at Virginia Tech Montgomery Executive Airport (BCB). Table 2 shows some of the aircraft fleet mix operating at the airport.

a) Use the Climate Explorer website to estimate the design temperature conditions for the airport. The link to the Climate Explorer is on our interesting web site page (http://128.173.204.63/cee5614/sites_ce_5614.html#Weather). Use the temperature profile for Blacksburg or the closest city.

- Consider climate change effects (i.e., higher emissions) and find the future design temperature. Use the future temperature profile for years 2035-2065.

Table 2. Existing Aircraft Fleet Mix for Problem 3.

| Aircraft Type | Aircraft | Annual Departures / Arrivals | Picture |
|---------------|---------------------------|------------------------------|--|
| Jet | Cessna Citation Latitude | 650 |  |
| Turboprop | King Air B350 | 1,450 |  |
| Jet | Bombardier Challenger 350 | 560 |  |

| Aircraft Type | Aircraft | Annual Departures / Arrivals | Picture |
|---------------|--------------------|------------------------------|---|
| Jet | Embraer Phenom 300 | 800 |  A white Embraer Phenom 300 jet is shown on a runway. The aircraft has a distinctive T-tail and a red and blue stripe on the fuselage. The registration 'N3100S' is visible on the rear fuselage. The background shows a grassy field and some trees. |

For **existing runway length conditions** and the **historical design temperature** answer the following:

- Find the critical aircraft operating at BCB using dry and wet runway conditions. Use the historical temperature conditions. Explain.
- For dry runway conditions, find the **takeoff weight** and **useful load** possible for the Bombardier Challenger 350 operating from the existing runway. Use the historical temperature conditions.
- Using the existing runway length at BCB, find the maximum distance that can be flown by a Cessna Citation Latitude with the average passenger load and two pilots?
- Considering climate change future temperature projections and dry runway conditions, find the takeoff weight and useful load possible for the Challenger 350 operating from the existing runway. Comment on any changes compared to part (b).
- Find the percent of the flights percent in the US by the Cessna Citation Latitude are covered? Use the historical temperature conditions.